

Regional survey on the consumption in the tertiary sector buildings - ARAGON -

PROJECT TITLE: Enhancing Mediterranean Initiatives Leading SMEs to innovation in building energy efficiency technologies

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OBJECTIVE: Dissemination of innovative technologies and know-how

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EXECUTIVE SUMMARY

This survey is part of the EMILIE project, funded by the “Mediterranean” transnational cooperation Programme and aiming to support the growth potential and capacity for innovation of small and medium enterprises (SMEs) in the field of energy efficiency in buildings in the tertiary sector at the transnational level, in order to actively contribute to growth, competitiveness, and employment in the Mediterranean area. The document provides review of existing data sources on energy consumption in the tertiary sector in Aragon (as one of the 6 participating regions within the project), with special focus on studies and sources of data on energy consumption in buildings and related legislation, standards and supporting mechanisms, as well as an updated overview about the key tertiary sector buildings energy needs, status and potential for energy refurbishment.

A general description of the current status of buildings in tertiary sector contains data on typical buildings structure typologies in Aragon and buildings specifics according to their building technology. Quantitative data of energy and heating sources, energy consumption and status of energy related systems, as well as potential for energy savings and application of pilot technologies from EMILIE project are collected for five the most typical types of buildings in tertiary sector like schools, hospitals, public administrative buildings, hotels and shopping centres. In addition to this, general analysis and assessment of the potential for tertiary building energy refurbishment is elaborated.

This survey as well as the other regional surveys are available for download from the EMILIE project website, www.emilieproject.eu.

RESUMEN EJECUTIVO (EXECUTIVE SUMMARY IN SLOVENIAN LANGUAGE)

Esta encuesta forma parte del proyecto EMILIE, financiado por el Programa de cooperación transnacional del Mediterráneo (MED – Programme), cuyo objetivo es apoyar el potencial de crecimiento y la capacidad de innovación de las pequeñas y medianas empresas (PYME) en el campo de la eficiencia energética en los edificios del sector terciario a nivel transnacional, con el fin de contribuir con ello activamente al crecimiento y la mejora de la competitividad de las empresas, así como a la generación de empleo en la zona del Mediterráneo.

La descripción general de la situación actual de los edificios en el sector terciario se ha hecho teniendo en cuenta tanto la tipología más común según su estructura de los edificios de Aragón, así como otros edificios más específicos de acuerdo a su tecnología. Datos cuantitativos sobre recursos energéticos, consumo energético, estado de los equipos relacionados con el sistema de climatización, así como el potencial de ahorro energético y la aplicación de las tecnologías piloto del proyecto EMILIE, han sido analizados en 5 de los tipos de edificios más comunes del sector terciario: escuelas, hospitales, edificios públicos administrativos, hoteles y centros comerciales. Además de esto, se ha elaborado un análisis general y una evaluación del potencial de rehabilitación energética de los edificios del sector terciario.

Esta encuesta, así como las otras encuestas regionales, se encuentran disponibles para su descarga desde el sitio web del proyecto EMILIE, www.emilieproject.eu.

Introduction

At the European level, the main policy driver related to the energy use in buildings is the Energy Performance of Buildings Directive (EPBD, 2002/91/EC). Implemented in 2002, the Directive has been recast in 2010 (EPBD recast, 2010/31/EU) with more ambitious provisions. Through the EPBD introduction, requirements for certification, inspections, training or renovation are now imposed in Member States prior to which there were very few. All EU countries now have functional energy performance certification (EPC) schemes in place.

The services sector includes both commercial service activities (banking, cinemas, hotels, retail outlets residential buildings and swimming pools) and public services (universities, hospitals and health centre, local authorities and government departments). Energy used in the non-residential sector provides a wide range of services: heating, cooling, lighting, refrigeration, cooking in some sectors, and various other end uses. Buildings are the predominant point of energy consumption (for space heating, lighting and water heating) within the services sector, the balance being mainly represented by certain municipal and civic facilities. In this report, the tertiary sector refers to the public sector, healthcare, services and commerce. The tertiary sector accounts for a large share of GDP in most of countries across the European Union and MED region as well. More than two third of the total value added is generated by the services sector (including public sector) and this figure is also expected to further grow in importance during the next years.

This survey is conducted in the framework of the EMILIE project and is aiming to provide an updated overview about tertiary sector buildings energy needs, equipment stock and energy consumption within existing buildings of the public, commercial, tourist and educational sectors. It constitutes data for Aragon, that characterize most major tertiary sector types of buildings, their characteristics, energy consumption, equipment and potential for energy savings as well as application of the pilot technologies from EMILIE project and introduction of renewable energy sources. However, this survey does not directly gather other information that is important to forecasting future energy consumption, such as equipment cost information or efficiency ratings, but could serve as an useful overview of the fields and technologies which offer future business opportunities particularly for local SME's and industry.

In order to clarify the meaning of term 'tertiary' or 'non-residential' buildings the following definitions could be used: 'A building is regarded as a non-residential building when the minor part of the building (i.e. less than half of its gross floor area) is used for dwelling purposes. Non-residential buildings comprise: industrial buildings; commercial buildings; educational buildings; health buildings; other buildings. [Source: OECD Glossary of statistical terms]' and 'Non-residential buildings are buildings other than dwellings, including fixtures, facilities and equipment that are integral parts of the structures and costs of site clearance and preparation. Historic monuments identified primarily as non-residential buildings are also included. Examples include warehouse and industrial buildings, commercial buildings, buildings for public entertainment, hotels, restaurants, educational buildings, health buildings, etc. [Source: Eurostat, "European System of Accounts - ESA 1995", Office for Official Publications of the European Communities, Luxembourg, 1996]'.

1. SOURCES OF DATA

1.1. PUBLISHED ESTUDIES ON ENERGY CONSUMPTION

Aranda-Usón, A., et al., Phase change material applications in buildings: An environmental assessment for some Spanish climate severities. *Science of The Total Environment*, 2013. 444(0): p. 16-25.

Gobierno de Aragón, Departamento de Salud y Consumo, Dirección General de Consumo, *Consumo de responsable y cambio climático*. (2010). <http://www.aragon.es/consumo/bibliodigital/45371.pdf>

Manual de Ahorro y eficiencia energética en el hogar. Hogares Aragoneses frente al cambio climático. Z-3.165-08. http://www.fundacionentorno.org/accionco2/08/documentos/03_Hogares_Climatico.pdf

Marcos González Álvarez. Nueva directiva relativa a la Eficiencia Energética de los Edificios. (Directiva 2010/31). http://www.idae.es/index.php/mod.documentos/mem.descarga?file=/documentos_1.-_Marcos_Gonzalez_12eef70d.pdf

Pasupathy, A., R. Velraj, and R.V. Seeniraj, Phase change material-based building architecture for thermal management in residential and commercial establishments. *Renewable and Sustainable Energy Reviews*, 2008. 12(1): p. 39-64.

SARGA – Sociedad de Gestión Agroambiental. Environmental sustainability report. Aragon Energy Plan. (2013-2020). http://www.aragon.es/estaticos/GobiernoAragon/Departamentos/IndustrialInnovacion/Areas/Energ%C3%ADa/Informe%20de%20Sostenibilidad%20Ambiental%20PLEAR%202013_2020.pdf

Kloppmann, W., et al., Building materials as intrinsic sources of sulphate: A hidden face of salt weathering of historical monuments investigated through multi-isotope tracing (B, O, S). *Science of The Total Environment*, 2011. 409(9): p. 1658-1669.

Kuznik, F., et al., A review on phase change materials integrated in building walls. *Renewable and Sustainable Energy Reviews*, 2011. 15(1): p. 379-391.

Zhang, Y., et al., Application of latent heat thermal energy storage in buildings: State-of-the-art and outlook. *Building and Environment*, 2007. 42(6): p. 2197-2209.

1.2. AVAILABLE SOURCES OF ENERGY DATA

ARAGONESE INSTITUTE OF STATISTICS



In the Aragonese Institute of Statistics, various studies are available statistical indicators, consumption, on a variety of topics, such as, planning, environment, energy, infrastructure, and the others.

http://www.aragon.es/DepartamentosOrganismosPublicos/Organismos/InstitutoAragoneseEstadistica/AreasTematicas/14_Medio_Ambiente_Y_Energia/ci.18_Energia.detalleDepartamento?channelSelected=ea9fa856c66de310VgnVCM2000002f551bacRCRD

MINISTRY OF AGRICULTURE, FOOD AND ENVIRONMENT



Data on energy aspects related to the economic activities included in this Ministry, such as primary energy consumption, energy intensity, etc.

www.magrama.gob.es/en/

INSTITUTE FOR DIVERSIFICATION AND ENERGY SAVING



IDAE conducts dissemination and training, technical assistance, development of specific programs and projects financing technological innovation and replicable nature. Also, the Institute leads an intense international activity under various European programs and cooperation with third countries. Relating studies, statistics and projects.

<http://www.idae.es>

THE MINISTRY OF INDUSTRY, ENERGY AND TOURISM



The Ministry of Industry, Energy and Tourism leads the proposal and implementation of government policy on energy, industrial development, tourism, telecommunications and the information society.

In this link, more information about statistics carried out and the main economic indicators can be found:

<http://www.minetur.gob.es/es-ES/IndicadoresyEstadisticas/Paginas/Estadisticas.aspx>

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NATIONAL INSTITUTE OF STATISTICS



Large amount of statistical information freely accessible to all users from the Spanish Official Statistics. Along with the statistical data offered on the economy, demographics and Spanish society, the information in this website includes institutional and methodological data, as well as various activities and services that the INE provides to different user segments.

<http://www.ine.es/>

GOVERNMENT OF ARAGON



DEPARTMENT OF INNOVATION AND INDUSTRY

General Directorate for Energy and Mines

It manages annual aid on savings and energy diversification, rational use of energy, use of indigenous and renewable resources and energy infrastructure.

They are responsible for Registration Certificates Energy Performance of Buildings in Aragón.

CIVIL ENGINEERING, PLANNING, HOUSING AND TRANSPORT

Department of Housing and Rehabilitation

Within this Department, the Restoration and Rehabilitation Service performs multiple works of recovery and enhancement of buildings of interest that are part of the architectural heritage of Aragón.

They also provide general information on rehabilitation: protected actions, where aid process, general conditions of rehabilitation activities, protected budget, etc.

www.aragon.es

1.3. LEGISLATION REVIEW INFLUENCING ENERGY EFFICIENCY AND USE OF RENEWABLE ENERGY IN BUILDINGS

Scope: Local

Municipality: Zaragoza

Legal 1:

- **Organization:** Zaragoza City Council
- **Organization web site:** <http://www.zaragoza.es/sedeelectronica/>
- **Abstract:** Ordinance on energy eco-efficiency and use of renewable energies in buildings and facilities:
It regulates the building with bioclimatic criteria and promotes the rational use of energy, favoring energy efficiency to achieve greater savings of energy in all actions of the building, and incorporate renewable energy. The aim is to achieve a substantial improvement in the energy system of the municipality, through measures of design, savings, efficiency and use of renewable energy, while maintaining the conditions of comfort and quality of the air and thereby improving the quality of life of citizens.
- **Affected Techniques:**
 - Installation of heating and/or hot water individual boilers of the so-called “high efficiency”.
 - Placement of water heaters and electric consumption devices of class “A”.
 - Rehabilitation of buildings and thermal installations to reduce the consumption of any type of energy.
 - Design of the building incorporating passive solar use elements.

Legal 2:

- **Organization:** Zaragoza City Council
- **Organization web site:** www.zaragozavivienda.es
- **Abstract:** Municipal ordinance to building rehabilitation: The purpose of this Ordinance is to regulate municipal actions, aimed to foster the rehabilitation works of private initiatives in the municipality of Zaragoza. To this end, it defines its scope and it classifies these performances of rehabilitation, as well

as the reference to the urban development Municipal regulations according to the characteristics of the buildings which constitute its object.

– **Affected Techniques:**

- Actions for the structural adaptation of buildings.
- Actions for the functional adaptation of buildings.
- Actions for the adaptation of the habitability of housing.
- Actions of remodeling or restructuring of homes or buildings.
- Actions of adaptation for urban planning regulations.

Scope: Regional

Region: Aragón

Legislation 1: Aragon Energy Plan, First Document. (2013-2020)

– **Organization:** Government of Aragon. Department of Industry and innovation. (First document)

– **Organization web site:**

<http://www.aragon.es/estaticos/GobiernoAragon/Departamentos/IndustrialInnovacion/Areas/Energ%C3%ADa/Primer%20Documento%20PEAR%202013-2020.pdf>

– **Abstract:** Planning for renewable energy, saving and efficient use of energy and energy infrastructure, including the program corresponding to the supply, demand, and electricity grids and gas and gas sectors.

– Is a transposition of a Community Directive 2012/27/UE.

Legislation 2: 1/2008 Law, of April 4, that approves urgent measures for the adaptation of urban management to the 8/2007, of May 28, soil, guarantees of sustainability of urban planning and drive to active policies of housing and land in the Autonomous Region of Aragon.

– **Organization:** Government of Aragon

– **Organization web site:** www.aragon.es

– **Abstract:** This law aims to adapt the urban system in force in the autonomous community of Aragon to the 8/2007 Law, of May 28, of soil, to impose the necessary measures to ensure the environmental and social sustainability of urban planning, facilitate access to decent and adequate housing and the precise actions to promote policies that contribute to facilitating access to housing in Aragon.

Scope: National

Country: Spain

Legislation 1: Royal Decree 314/2006: Technical building code (CTE)

– **Organization:** General Management of architecture, housing and ground

– **Organization web site:**

http://www.fomento.gob.es/MFOM/LANG_CASTELLANO/DIRECCIONES_GENERALES/ARQ_VIVIENDA/

- **Abstract:** The technical building code is a legislative instrument that sets out the basic requirements of quality of buildings and their facilities. Through this regulation satisfies certain basic building requirements related to the safety and welfare of persons.
- **Affected Techniques:** Structural safety and protection against fires, health, protection against noise, energy saving or accessibility for people with reduced mobility.
- Is a transposition of a Community Directive 2002/91/CE Directive

Legislation 2: Royal Decree 1027/2007: Regulation of thermal installations in buildings (RITE)

- **Organization:** Ministry of industry, tourism and trade and the Ministry of housing
- **Organization web site:** <http://www.minetur.gob.es/es-ES/Paginas/index.aspx>
- **Abstract:** The regulation of thermal installations in buildings (RITE), lays down the conditions to be fulfilled by the installations designed to meet the demand of thermal well-being and hygiene through the installations of heating, air conditioning and hot water, to achieve a rational use of energy.
- **Affected Techniques:**
 - More energy performance in the heat and cold generation equipment, as well as those intended for the movement and transport of fluids.
 - Better insulation in the equipment and piping of thermal fluids.
 - Better regulation and control to keep the estimated design requirements in the air-conditioned premises.
 - Use of available renewable energies, especially solar energy and biomass.
 - Incorporation of subsystems of energy recovery and the use of waste energy recovery.
 - Mandatory consumptions counter modules in the case of collective installations.
 - Gradual disappearance of more polluting fossil fuels.
 - Gradual disappearance of less efficient generation equipment.
- Is a transposition of a Community Directive: 2002/91/CE Directive

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Legislation 3: Royal Decree 47/2007: Energy certification of buildings

- **Organization:** Ministry of industry, tourism and trade and the Ministry of housing
- **Organization web site:** <http://www.minetur.gob.es/es-ES/Paginas/index.aspx>
- **Abstract:** Regulation that forces to certify the energy efficiency of buildings of new plant and major reforms (from 1000 m² of floor space and the reform of at least 25% of the envelope). Open and religious buildings, protected monuments, agricultural or industrial buildings, those buildings with an estimated period of use less than 2 years or whose useful surface does not exceed 50 m² are exempt from such requirement.
- **Affected Techniques:**
 - Identification of the building.
 - Indication of the energy regulations applicable at the time of the construction of the building.
 - Indication of the option of chosen certification: General or simplified. In the latter case, it should be indicated the computer reference software or alternative used for energy efficiency rating.
 - Description of the energy characteristics of the building, thermal envelope, installations, normal operation and occupation and other data used for rating energy efficiency of the building.
 - Rating of the building energy efficiency expressed by means of the corresponding standard tag.

- Description of tests, checks and inspections carried out during the execution of the building for the purpose of establishing the conformity of the information contained in the certificate of energy efficiency with the finished building.
- Is a transposition of a Community Directive 2002/91/CE Directive

Legislation 4: Savings Action Plan and energy efficiency. (2011-2020)

- **Organization:** Ministry of industry, tourism and trade
- **Organization web site:**
http://www.minetur.gob.es/energia/es-es/novedades/documents/paabee2011_2020.pdf
- **Abstract:** The 2011-2020 Action Plans presents a set of measures and actions scenarios consistent with the final and primary energy consumption, and the other planning instruments in renewable energy and planning of the electricity and gas sectors.
- **Affected Techniques:** For Building and Equipment Sector as a result of the sum of the savings in residential building, on one hand, and in building tertiary use, on the other, plus the savings from efficiency improvements energy appliances and office equipment (in turn, the savings associated with the construction, whether residential or tertiary, are the result of add savings in heating, cooling and hot water health and savings from energy efficiency improvements in lighting).
- Is a transposition of a Community Directive 2009/28/EC.

2. GENERAL REVIEW OF TERTIARY SECTOR BUILDINGS

2.1. GENERAL DESCRIPTION OF THE CURRENT STATUS OF BUILDINGS

The population comprised in Aragón is approximately of 1.350.00 inhabitants, distributed in three provinces (Zaragoza, Huesca and Teruel)

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Technical review:

- Construction Standards:
 - Technical building code (CTE): Basic and technological standards and approved building solutions with their document of technical suitability.
 - Passivhaus: Creation of a non-profit association that aims to adapt and develop the Passivhaus standard in Spain. The PEP (Plataforma de Edificación Passivhaus) will be constantly in contact with other partners and institutions in Spain and across Europe, with particular attention to the other Mediterranean countries to share information and experiences made. The platform aims to finally establish a methodology for certification and control of the Passivhaus Standard in Spain, as a way of ensuring its smooth functioning.
- Use of National Assessment Methodologies: VERDE (GBCe's Environmental Certificate) acknowledges the reduction in environmental impact of the building, compared to a standard reference building. This building is a model conceived according to the minimum parameters established by law and common practice. VERDE entails the recognition by an independent organization, unrelated to the developer or designer, of the ecological values of a building by applying an internationally approved evaluating method.
- Use of energy simulation tools: LIDER, CALENER VYP/GT, Energy+ (Design Builder).
- Use of life cycle assessment / life cycle cost tools: Gabi, SimaPro.

- ¹ Use of EPDs (Environmental product Declarations): DAPc system: The DAPc system is a pioneer in the Spanish State that brings together companies manufacturers of products and construction materials which have sensitivity and a commitment to sustainability and the environment, and who want to advance in the analysis of the environmental impacts of their products.
- ¹ Renewable energy technologies to be integrated in buildings: Solar thermal & photovoltaic.
- ¹ Materials and constructive solutions commonly used:

Nº	Material
1	Brickwork
2	XPS Extruded polystyrene
3	Concrete block (medium)
4	Gypsum plastering

External wall (from outside to inside)

Nº	Material
1	Gypsum plasterboard
2	Air gap 10mm
3	Gypsum plasterboard

Partition Wall

Nº	Material
1	Cast concrete

Internal floor structure

Nº	Material
1	Timber flooring
2	Floor/Roof screed
3	Cast concrete
4	Urea formaldehyde foam

Ground floor structure (from top to bottom)

Nº	Material
1	Timber flooring
2	MW Stone wool
3	External rendering

External floor structure (from top to bottom)

Nº	Material
1	Clay tile (roofing)
2	MW Stone wool
3	Roofing felt

Roof (from outside to inside)

Quantification (estimation) of indicators for key types of buildings

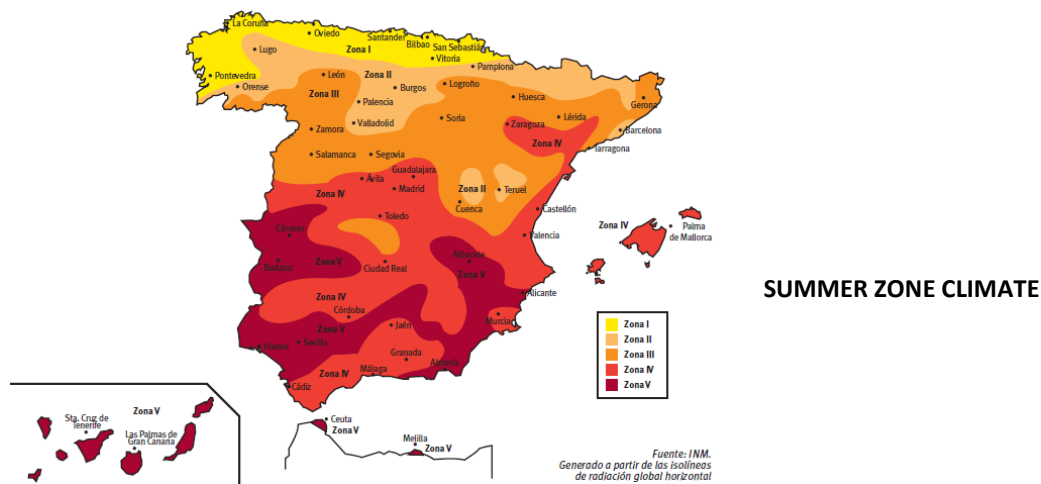
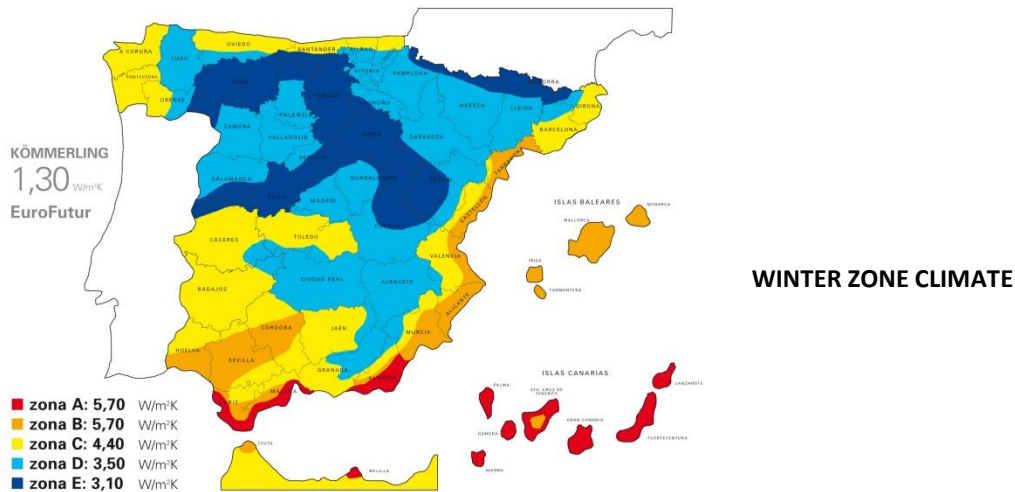
Type of building	Indicator	Value	% of total buildings area
Schools, research, other educational buildings	Area (average) Number of students	3.000 m ² / school 1.024 buildings = 3,07 Km ² 160.722 students	23,68
Hospitals, retirement homes other health/social buildings	Area (average) No. of rooms/beds	3.000 m ² /hospital 1.018 buildings = 3,054 Km ² 5.404 beds	23,54
Offices, administrative (municipal and other public administrative) buildings	Area (average)	100 m ² /building 45.000 ¹ business premises = 4,5 Km ²	34,68
Hotels, restaurants, other tourist buildings	Area (average) No. of rooms/beds	800 m ² /building 2.870 tourist accommodation = 2,29 Km ² 96.217 seats	17,65
Shopping, retail centres	Area (average)	4.000m ² /building 14 retail centres = 0,06 Km ²	0,43

Table 1: Indicators for key types of buildings Aragón

¹ Instituto Aragonés de Estadística. Resultados del Sector Servicios. Encuesta anual de Comercio (INE). Estimated data for 2011.

2.2. OVERVIEW OF ENERGY CONSUMPTION

In terms of energy demand requirements, Spain is represented by the winter climatic zones (5 areas identified by a letter) and the summer climatic zones (4 areas identified by a number) as defined in the CTE-DB-HE1. The establishment of such zones is carried out through the climatic severity, combining the influence joint of outdoor temperature and solar radiation in the months of winter and in the summer months. Zaragoza is located in the climatic area D3.



→ **Status of public awareness:** Although increasing, the status of public awareness is still insufficient in Spain. For that reason the activities of public business entities such as IDAE (Institute for the diversification and saving of energy) attached to the Ministry of industry, energy and tourism are so necessary. The implementation of training and awareness campaigns and the development of informative content aimed to build a social culture of energy that takes into account the value of

resources and the need to consume them in an intelligent manner, is, likewise, one of the main commitments of this entity.

- ¹ **Social acceptance about Renewable Energies in urban areas:** The introduction of renewable energies has a broad base of social, political and trade union support. The general public perceives technology as something modern and beneficial, especially in the new context of the fight against global warming, from which the European Union, the Spanish State and the regional authorities present renewable energy as very important for the society and progress. According to the Eurobarometers, 90% of Spaniards believe that renewable energy sources should have a minimum base fee in the generation mix. Among those who oppose these types of energy, the most relevant are the ones involved in the conventional energy business, and those criticizing the landscape deterioration by renewable energy plants.

Place	Heating degree days (base air temperature 19°C) ²	Cooling degree days (base air temperature 26°C) ³	Annual incident energy on south oriented plane with 45° Slope	Av. Ambient temperature over year °C	Av. Ambient temperature over heating season °C
Aragón	1.294	208	1885.00 kWh/m ² ·YEARS	15	21,5

Source: Own compilation

- Maximum ambient temperature over year: 21.00 °C
- Avg. ground / water temperature over year: 13.00 °C
- Avg. ground / water temperature over heating season: 9.00 °C
- Avg. ground / water temperature over cooling season: 17.50 °C
- Avg. ambient wet bulb temperature over cooling season: 18.60 °C
- Avg. ambient temperature during daylight over cooling season: 24.10 °C
- Avg. solar irradiation during daylight over cooling season: 435.80 W/m²

² The heating degree days (DD) compute the sum of the daily negative (below) differences between the threshold temperature, in this case 19°C, and the real temperature along the whole year.

³ The cooling degree days (DD) compute the sum of the daily positive (above) differences between the threshold temperature, in this case 26°C, and the real temperature along the whole year.

Reference, <http://www.geoclusters.eu/ge20/index.jsf>

Distribution of heating types/fuels (Table 2)

[ktoe]	2008	2009	2010	2011
Tertiary sector (Spain)				
<i>Coal</i>	58	54	56	0
<i>Liquid fuels</i>	2017	1906	1963	1345
<i>Natural gas</i>	872	824	849	1020
<i>RES</i>	139	131	135	104
<i>Electricity</i>	6478	6121	6304	7072

Source: IDAE. Informe Anual de Consumos energéticos en España.

The following table corresponds to the distribution by type of heating for Aragon.

[ktoe]	2008	2009	2010	2011	Δ 2011- 2008
Total final energy consumption⁴	3912	3670	4028	3498	84,42%
Tertiary sector (Aragón)					
<i>Coal</i>	2	2	2	0	-
<i>Liquid fuels</i>	58	54	56	38	65,52%
<i>Natural gas</i>	25	24	24	29	116%
<i>RES</i>	4	4	4	3	75%
<i>District heat⁵</i>	0,28	0,28	0,28	0,21	75%
<i>Electricity</i>	185	175	180	202	109,19%

Source: IDAE. Informe Anual de Consumos energéticos en España

NOTE⁵:

- The number of networks in Aragon is 4
- Aragon Supply Type: Heat: 1, and Heat + Cold: 3
- Aragon represents the 7% of power installations in Spain.

⁴ "Boletín de Coyuntura Energética" del Departamento de Industria e Innovación del Gobierno de Aragón.

⁵ Pérez de Lema, Miguel. (2012). Desarrollo de los District heating en España. *Energética XXI*. nº 124

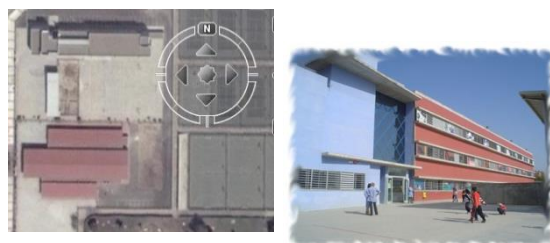
Final tertiary buildings energy use, structure (share) of final energy consumption for tertiary sub sectors.

	Total (sub sector) [GWh]	% (of total sector)	Specific energy use [kWh/m ² a]
Schools, research, other educational buildings	958,6	20,08	312
Hospitals, retirement homes other health/social buildings	1.201,88	25,18	394
Offices, administrative (municipal and other public administrative) buildings	982,28	20,58	218
Hotels, restaurants, other tourist buildings	276,26	5,79	121
Shopping, retail centres	1.354,25	28,37	2.116

3. ENERGY ANALYSIS OF BUILDING TYPES

3.1. CURRENT ENERGY CONSUMPTION

3.1.1. Primary schools

Short description of the typical primary school building In Aragón there is a total of 383 schools, for public and private primary education (247 in Zaragoza, 56 in Huesca and 80 in Teruel). Most of the buildings were built during the 60s, despite having been rehabilitated in order to improve the adequacy of facilities. The average surface of the centers to be heated is approximately 3.500 m ² , being the largest area of 8.500 m ² and the smallest around 1.100 m ² .		Picture of typical building				
						
Building heating area (m ²)		3.500 m ²				
Energy consumption of the building						
Electricity (MWh)		78,39				
Fuels, district heat, RES (MWh)		277,90				
TOTAL (MWh)		356				
Specific energy consumption for heating (kWh/m ²)		274,35				
Specific electricity consumption (kWh/m ²)		71,26				
	Heating	Cooling (VAC)	Hot water	Lighting	Other	
Share in energy consumption [%]	78 %	0%	-	20%	2%	
Remarks on data quality (real) The data used are real, from the energy audit (elaborated by CIRCE)						
Short description of the energy related systems						
Envelope: Isolation of schools is based on current regulations at the time of the construction. The average age of most centers is 1973, that is, 40 years. Since the current regulations at the time of its construction did not require specific conditions for ceiling or flooring isolation, it is hard to assess an average for schools.						

HVAC systems:

The heating system used is a zoned under floor six spaces and hot water production by two gas boilers. It operates throughout for an average of 8 hours per day, depending on external conditions and demand. The temperature set point is selected by thermostats located in each room and whose handling is impaired, as temperatures are set by the maintenance staff to 20°. The building is heated by two condensing boilers for natural gas that supply hot water radiators, which also regulates the temperature by room thermostats, with hours of operation from 7 to 12 in the morning, when the boiler is off.

Energy management status in the buildings:

Trained energy manager employed in the building	Regular collection of energy consumption and cost data (bills)	Analysis of consumption (performance calculation, targets, etc.)	IT Energy management system installed (metering and on line collection of data)
Rarely	Yes	No	No

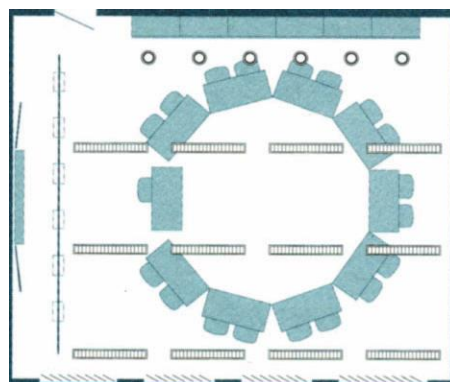
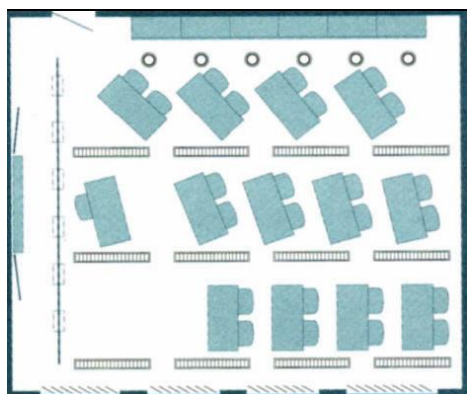
Potential for energy savings/refurbishment

Envelope insulation	Windows replacement	Heating	Cooling (VAC)	Lighting	Other (specify)
Medium	Medium	Low	Medium	High	-

Comments:

The ratio assigned refers to the degree of complexity that would implement the energy saving measures for each item.

- Windows replacement, switch to double crystal for the windows or other innovative solutions (such as PCM).
- Sector the Heating.
- Conduct a study of turnover to raise the possibility of disconnecting the HVAC system in times of increased electricity prices (peak), or at least part of this time, taking advantage of the high thermal inertia of the system and in some areas in winter the temperature of the building is high too.
- Regulate Lighting.



Recommended guidelines in a classroom to optimize the use of outdoor lighting

Potential application of the pilot technologies from EMILIE project

Solar heating & cooling	HVAC optimisation	Energy management	PCM
Hardly applicable	Very applicable	Very applicable	Very applicable

Comments:

Solar Heating and Cooling could be technically feasible but its installation cost, in the present situation, presents a great barrier for schools, especially those depending on public funds.

Potential introduction of renewable energy sources (RES) in buildings

Comments:

Cogeneration (likely applicable)

Cogeneration can be defined as the sequential use of a single fuel to produce electricity and thermal energy (usually high pressure steam, hot water and hot air), with which up to 40 % more efficient fuel consumption can be reached, compared to separate production.

Therefore, the cogeneration technology can be applied to any type of system with a medium or high demand of thermal energy (steam, hot water, cooling, etc.)

This technology has a considerable potential for large buildings of the tertiary sector, being its biggest disadvantage that these centers main time for production is during the mornings, making it necessary to disconnect the system during the afternoons, evening and nights, which leads its operation to a short profitability.

Solar thermal Energy (applicable)

Solar thermal energy is capturing the sun's radiation and transforming it into heat for use in various applications using devices called solar collectors. This application may cover more than 60% of hot water needs. This technology would be feasible and interesting whereas the HVAC system is centralized and therefore, the installation of pipes, tanks, solar collectors and so on, can reach the whole building.

Solar photovoltaic (applicable)

As in the previous case, it is a possible solution, especially considering the availability of roofs and free access surfaces. The main barrier, however, would be the cost of the installation, in opposition to the savings achieved in electricity consumption bills.

Installation of biomass boilers (likely applicable)

Biomass is a source of energy from the sun indirectly and can be considered a renewable energy providing you follow a suitable environmental parameters and operating use.

The actual boilers tend to consume natural gas, so replacement will depend on its obsolescence, level of pollution, and cost of a biomass alternative

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Entrance to the building of early childhood education



Windows

3.1.2. Hospitals

Short description of the typical hospitals building In the community of Aragón there are 29 hospitals (specifically in Huesca 7 hospitals and 767 beds installed, in Teruel 4 hospitals with 556 beds installed and in Zaragoza 18 hospitals and 4.137 beds installed). Urban centers typically have an average size of 2.500-3.500 m ² while the rural ones usually have lower areas (1.000-1.200 m ²) and their variability in size is much higher than the case of urban centers. Big hospitals usually have an area of about 6.000 m ² , although it varies depending on different factors. As an example, the Universitas Health Center was built in 1994 and includes the characteristics of the health urban centers built in the 90s.	Picture of typical building 						
Building heating area (m ²)		2.589					
Energy consumption of the building							
Electricity (MWh)		275,76					
Fuels, district heat, RES (MWh)		220,93					
TOTAL (MWh)		496,69					
Specific energy consumption for heating (kWh/m ²)		85					
Specific electricity consumption (kWh/m ²)		30,9					
	Heating	Cooling (VAC)	Hot water	Lighting	Other		
Share in energy consumption [%]	44,5 %	21%	2,5%	25,5%	6,5%		
Remarks on data quality (real) The data used are real, from the energy audit of Building Universitas (elaborated by CIRCE)							
Short description of the energy related systems							
Envelope: Isolation of the hospital is in accordance to the regulations at the time of construction. In the vast majority it did not specify whether there are any special insulation in walls, ceilings and floors. Regarding the glazing of the centers, most of them have double glazed windows and suitable enclosures. Only one hospital has presented anomalies. The joinery enclosure is whether wooden (in oldest buildings) or aluminum. As observed in other centers, presence of large glazed surfaces (29% of the total area of vertical walls) due to its orientation provides no solar gain and therefore energy savings in heating, but on the contrary, its transmissivity causes greater heat loss in winter. Shutters are not available in any room of the center, so that thermal losses or excessive heat gain in summer can be avoided during the night. There are sunscreens or blinds, so that major losses occur while heating in winter and through excessive heat gain in summer, which increases consumption of both heating and cooling. Lighting levels are also found too high in some areas, while in others there is virtually no natural light, despite having large glass and skylights, as has been observed in other centers.							

HVAC systems:

The air conditioning of the building is performed by a system in the production of hot water for heating, having three natural gas boilers condensation (87kW) of maximum power (the system was changed in 2006). The remaining of the pumping station, distribution, and others has a total power of about 5.5 kW. The water treated and conditioned, is 7° to 40° for cooling and heating. It is distributed through a two-pipe system to the terminal units fan coil type that found in queries, offices and waiting rooms. The production of domestic hot water is done centrally on two electric heaters of 4.5 kW each.



Condensing Boiler

Energy management status in the buildings:

Trained energy manager employed in the building	Regular collection of energy consumption and cost data (bills)	Analysis of consumption (performance calculation, targets, etc.)	IT Energy management system installed (metering and on line collection of data)
Rarely	Yes	Rarely	No

Potential for energy savings/refurbishment

Envelope insulation	Windows replacement	Heating	Cooling (VAC)	Lighting	Other (specify)
Low	Medium	Low	Low	Medium	-

Comments:

The ratio assigned refers to the degree of complexity that would imply the energy saving measure for each item.

- Temperature control heating set point terminal units. In tertiary sector buildings, in which users don't bear the cost of their consumption, the set point temperatures usually exceed those recommended in winter while in summer they are lower than recommended.
- The importance of consumption in this center cooling (VAC), makes control over its use and set point temperatures rather necessary.

Potential application of the pilot technologies from EMILIE project

Solar heating & cooling	HVAC optimisation	Energy management	PCM
<i>likely applicable</i>	Very applicable	Very applicable	Very applicable

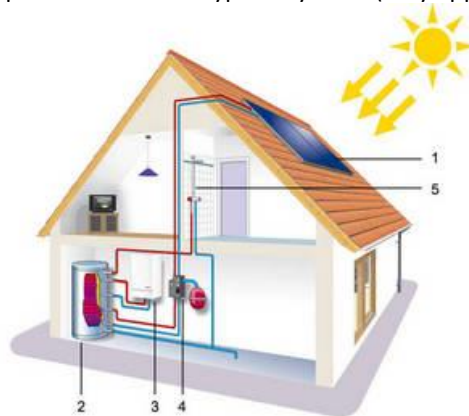
Comments: Due to the 24 hours need for heating and cooling, the solar heating & cooling tech. could become more profitable and economically feasible than in other types of buildings.

Potential introduction of renewable energy sources (RES) in buildings

Comments:

Integration of Renewable Energy

- **Cogeneration** (use of a single fuel to produce electricity and heat). This technology has significant potential in large buildings of the tertiary sector. Although these buildings have its main needs during the morning, the afternoons, evenings and nights are still periods where heating and electricity is requires, making this technology more profitable than in other cases. (likely applicable)
- **Solar thermal energy** is capturing the sun's radiation and transforming it into heat for use in various applications using devices called solar collectors. This application may cover more than 60 % of hot water needs. This type of centers is suitable for the installation of solar energy since they tend to have a centralized system of production and distribution of ACS, which makes it relatively simple to include this type of system (very applicable).



Scheme type of a solar thermal installation

- **Solar PV**, in this case, it will strongly depend on the conditions of the building, its exposition to the sun, and the economic feasibility (likely applicable).



Glass structure on deck

- **Biomass**, for those buildings with already obsolete natural gas boilers, biomass could be a good opportunity since the boilers tend to be in separate floors or dependencies, and therefore space and operating tasks may not be a problem.



Hollow that connects the ground floor and first floor

3.1.3. Public Administrative buildings

Short description of the typical public Administrative building

The Pignatelli Building, seat of the GOVERNMENT OF ARAGON, was built at the end of the eighteenth century and later reformed in 1986.

In 1983 the Government of Aragon was installed in the Pignatelli Building and the project of renovation and adaptation of the institution to make it the government seat with all of its departments, centralized services and provincial services for Zaragoza began. Its facilities provide the necessary conditions in terms of representation and distinction to be the seat of government for Aragon. With the recovery of the former Pignatelli Home, Zaragoza gained an emblematic building of great significance in the modern history of Aragon. The building has a useful floor area of 28.000 square meters, and its installations have a capacity for 2.000 civil servants in working hours (currently 1.200 persons work here), around 700 Aragonese citizens/day who come to carry out administrative procedures and a large number of persons who attend the different activities that are staged at these facilities. It has a total floor area of approximately 48.500 m², distributed over five floors.

Picture of typical building



Building heating area (m²) **48.500**

Energy consumption of the building

Electricity (MWh)	3.836				
Fuels, district heat, RES (MWh)	0,639				
TOTAL (MWh)	3.836,64				
Specific energy consumption for heating (kWh/m ²)	-				
Specific electricity consumption (kWh/m ²)	84,79				
	Heating	Cooling (VAC)	Hot water	Lighting	Other
Share in energy consumption [%]	20,5%	18%	-	50%	11,5%

Remarks on data quality (real)

The data used are real, from the energy audit of Building Pignatelli (elaborated by CIRCE)

Short description of the energy related systems

Envelope:

As for thermal efficiency, still some of the windows of the building have a single crystal. It does not exist standardization for the light output depending on the sunlight. The computers screens tend to be connected even without the user presence, and equipment such as network printers or copiers are not completely disconnected at the end of workday.

HVAC systems:

The building's HVAC is by under floor heating, heat pumps with three water/ water units whose powers are 603 kW nominal cold , heat and 696 kW with a COP (coefficient of performance) of 4.6 and an EER (coefficient of cooling efficiency) for 6. The climate control is done manually by the technical department, and connects when the users demand it. Generally, the period of operation for heating is from October to April, and cooling from May to September. There are also approximately 348 fan-coils.

The under floor heating system has 1048 circuits, sectorized into 40 zones, grouped into 10 blocks, which divide the building zones vertically, comprising several plants each, and do not respond to climatic efficient criteria . Due to the high thermal inertia of the system (about 24 hours according to technical data provided by the Government of Aragon), once the air is connected it keeps running until the end of the season (hot or cold) all day.

The set point of the heating is usually 28°C , and cooling in 17°C water temperature in the under floor heating. Sectorial control is achieved by external temperature probes and three-way valves. The system has no thermostatic valves or a thermostat to the user, since they are controlled by the technical area.

Energy management status in the buildings:

Trained energy manager employed in the building	Regular collection of energy consumption and cost data (bills)	Analysis of consumption (performance calculation, targets, etc.)	IT Energy management system installed (metering and on line collection of data)
Rarely	Always	No	Rarely

Potential for energy savings/refurbishment

Envelope insulation	Windows replacement	Heating	Cooling (VAC)	Lighting	Other (specify)
Medium	Medium	High	Low	High	-

Comments:

The ratio assigned refers to the degree of complexity that would imply the energy saving measure for each item.

- Windows replacement, switch to double crystal for the windows.
- Sectorized the Heating.
- Conduct a study of turnover to raise the possibility of disconnecting the HVAC system in times of increased electricity prices (peak), or at least part of this time, taking advantage of the high thermal inertia of the system and the temperature in some areas of the building in winter is too high.
- Regulate Lighting.

Potential application of the pilot technologies from EMILIE project

(Rate: *very applicable, likely applicable, not applicable*)

Solar heating & cooling	HVAC optimisation	Energy management	PCM
<i>Hardly applicable</i>	<i>Very applicable</i>	<i>Very applicable</i>	<i>Very applicable</i>

Comments:

The solar heating & cooling tech. would be more or less applicable depending on the structure of the buildings and, therefore, its surface exposition to the sun. In many cases, the public buildings are located in the city center, and do not count on good roofs or facades to build up solar equipment.

Potential introduction of renewable energy sources (RES) in buildings

Comments:

The Solar Thermal Energy (likely applicable)

The possibility of installing solar thermal for hot water generation seems not recommended because the demand points are delocalized throughout the building, making it impossible to unify the generation of the same, as they lose an excessive amount of energy in the pipes and transport. Besides, there is no easy area to set the collectors.



Photovoltaic Solar Energy (partially applicable)

Although it will not be extensively used, some particular areas, such as a terrace on the third floor, can be used to supplement the need of electricity for the building.



The Pignatelli Building

3.1.4. Hotels

Short description of the typical hotels building	Picture of typical building				
<p>The Hotel "La Pardina" is located in Sabiñánigo city (Huesca).This hotel is a corporation, which is associated to the line of hotels "Fantasia".</p> <p>The hotel has 64 rooms (with a total capacity for 123 people), has 3 stars and is open throughout the year, being the summer months the maximum occupancy records.</p> <p>The hotel is a single building built in two distinct phases. The first phase was by 1970, while the second phase was in 1975. The building consists of a ground floor at street level and three upper floors.</p> <p>The main services offered by the hotel include disabled people access, air conditioning in rooms, elevator, heating, garage, garden, conference room, TV in rooms, telephone in rooms, snack bar, playground, swimming pool, satellite TV, cybernetic fountain. In addition there are 3 dining areas for 20, 110, and 250 people respectively.</p>					
					
Building heating area (m ²)	3.920				
Energy consumption of the building					
Electricity (MWh)	218,10				
Fuels, district heat, RES (MWh)	-				
TOTAL (MWh)	218,10				
Specific energy consumption for heating (kWh/m ²)	55				
Specific electricity consumption (kWh/m ²)	151,8				
	Heating	Cooling (VAC)	Hot water	Lighting	Other
Share in energy consumption [%]	36,7%	37,1%	-	13,2%	13,1%
Remarks on data quality (real)					
The data used are real, from the energy audit of Hotel La Pardina (elaborated by CIRCE)					
Short description of the energy related systems					
Envelope:					
Regarding the system of lagging pipes, it can be said that all lines observed in the boiler room, lack from any type of insulation, which makes the room temperature very high.					
The branches that come out of the boiler room are properly lagged, except for 4 lines of 36 meters each, which lack insulation.					
Tanks for storage of hot water may also be somewhat deteriorated in what regards insulation, resulting in some loss of heat.					
Finally, regarding the system of insulation in the building, it can be said that there are not special thermal insulation ceilings, floors, walls or walls. Thus the existing insulation is the one corresponding to the regulations in force in the year of construction of the building (old phase: 1970, modern phase: 1975).					
Furthermore, the hotel features double glazed windows just in the manager's office and the dining room, being the remaining structures of the hotel simple glass windows.					

HVAC systems:

The Hotel counts on cooling and heating all throughout the building. The capacitor of this equipment is shielded from the sun by means of reeds and trees, which impede Solar heat input, but also somewhat limits heat exchange with the outside.

Energy management status in the buildings:

Trained energy manager employed in the building	Regular collection of energy consumption and cost data (bills)	Analysis of consumption (performance calculation, targets, etc.)	IT Energy management system installed (metering and on line collection of data)
Rarely	Yes	Rarely	No

Potential for energy savings/refurbishment

(Rate: high, medium, low)

Envelope insulation	Windows replacement	Heating	Cooling (VAC)	Lighting	Other (specify)
High	Medium	Medium	Low	Low	-

Potential application of the pilot technologies from EMILIE project

(Rate: very applicable, likely applicable, not applicable)

Solar heating & cooling	HVAC optimisation	Energy management	PCM
Very applicable	Very applicable	Very applicable	Very applicable

Comments:

Potential introduction of renewable energy sources (RES) in buildings




Comments:

Saving measures can be important to optimize the boiler together with the HVAC, pipe insulation to the boiler room, and also the insulation of pipes leaving the boiler room.



Hotel "La Pardina"

3.1.5. Retail (shopping) centres

Short description of the typical shopping building The large shopping centre named “Puerto Venecia”, located in Pinares de Venecia, Zaragoza, has an area of 206.000 square meters and more than 4.000 parking places distributed throughout. One of the most impressive things of Puerto Venecia is the navigable lake which surrounds the different shopping and entertainment zones. It is intended for the enjoyment of the entire family ant it is divided into three zones: The Gallery, the leisure and adventure, ‘for the home zone’ and the lake. Without doubt, the main attraction of Puerto Venecia is this 10.000 square meters lake. A boat can be rented to sail, and in winter, a part of it becomes an ice rink. In addition, the Japanese bridge, lighting and decoration surrounding it, make an idyllic atmosphere to wander around.	Picture of typical building   					
Building heating area (m ²)	7.500					
Energy consumption of the building						
Electricity (MWh)		801,98				
Fuels, district heat, RES (MWh)		-				
TOTAL (MWh)		801,98				
Specific energy consumption for heating (kWh/m ²)		10,73				
Specific electricity consumption (kWh/m ²)		85,52				
	Heating	Cooling (VAC)	Hot water	Lighting	Other	
Share in energy consumption [%]	7%	53%	-	38%	2%	
Remarks on data quality (estimated) The data for the shopping center “Puerto Venecia”, are still estimated.						
Short description of the energy related systems						

Envelope:

The shopping center has 2 floors and an underground parking. For sound absorption, the ceilings installed Mono Acoustic TE panels Rockfon in a space of over 3.500 m² allowing ceilings to be flexible and functional, which easily integrate lighting, ventilation holes and systems sound. These rockwool panels (30 mm. thick) are provided with a white veil in the visible and a high performance contravelo on the rear.

The enclosures used in this great project with 50 CW systems for facades and curtain walls, and Pa CS 59, CS 59-CD, CS 59-SD, and Moorea Eco system for windows and doors.



Puerto Venecia buildings are designed so that energy consumption is minimized, while promoting the use of alternative energy (photovoltaic panels, natural ventilation and optimisation of sunlight). Also, drinking water is used exclusively for human consumption.

**HVAC systems:**

The machine's HVAC Puerto Venecia, is a magnetic levitation refrigeration compressor, each of the stores has its own system of air conditioning. Besides, used photovoltaic energy to supply part of the power required and the collection elements are integrated into the architecture, designed to optimize performance and aesthetics.

**Energy management status in the buildings:**

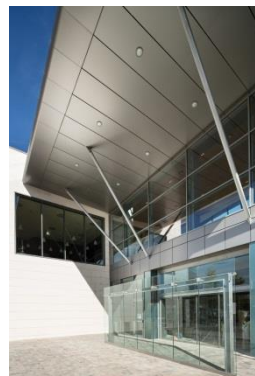
Trained energy manager employed in the building	Regular collection of energy consumption and cost data (bills)	Analysis of consumption (performance calculation, targets, etc.)	IT Energy management system installed (metering and on line collection of data)
Partially	Yes	Partially	Partially

Potential for energy savings/refurbishment

Envelope insulation	Windows replacement	Heating	Cooling (VAC)	Lighting	Other (specify)
Low	High	Medium	Medium	High	-

Comments:

The buildings are designed so that energy consumption is minimized, promoting the use of alternative energy (photovoltaic panels, natural ventilation and optimisation of sunlight), and limits the use of potable water for human consumption. However, innovative technologies such as PCM materials, solar cooling or other, have not been considered yet.

**Potential application of the pilot technologies from EMILIE project**

(Rate: *very applicable*, *likely applicable*, *not applicable*)

Solar heating & cooling	HVAC optimisation	Energy management	PCM
Very applicable	<i>Likely applicable</i>	<i>Likely applicable</i>	Very applicable

Comments:**Potential introduction of renewable energy sources (RES) in buildings****Comments:**

Puerto Venecia does already integrate some interesting solutions based on Renewables. However, new developments could be considered, especially regarding solar technologies and biomass expansion.

**3.2. ASSESSMENT OF DIVERSE TECHNOLOGIES EFFECTS ON THE SUPPLY CHAIN**

The development and commercial expansion of any of the technologies proposed may only have beneficial impact throughout the supply chain. Although some minor delays or market ruptures could arise in a first moment while the suppliers get ready to satisfy the new demand, it is clear that these kind of new markets offer great opportunities for diversification and international competitiveness.

For Isolation and solar cooling technologies, for instance, there are already suppliers present in the Spanish market which could satisfy the demand and grow with it, even developing new and more efficient (or economically interesting) alternatives.

In the case of PCM materials, the surge of a new local demand could lead to companies in the sector of windows and isolation to start designing and producing these sort of materials which, nowadays, are still seldom and rare in Europe.

Finally, the energy management enhancement could be seen as an opportunity to a wide spectrum of companies, from those advising and improving consumption standards, to those training professionals and company technicians to achieve more efficient behaviours.

3.3. ASSESSMENT OF THE EFFECTS OF DIVERSE TECHNOLOGIES IN TERMS OF ENERGY SAVINGS AND OVERALL ENVIRONMENTAL IMPACT

It is hard to accurately assess the impact of such measures in terms of Carbon emissions or energy savings, especially if the dimension of its implementation is unknown. In any case, if tertiary sector would see the benefits in terms of money savings, due to energy consumption reduction, the final impact in carbon emissions would be definitely huge. In a country like Spain, disparity over summer and winter in what refers to temperatures, leads to a rather common mismanagement of heating and cooling equipment and devices. Bringing this pattern to a more efficient approach, even if it is at a slow pace, will have a very significant impact in consumption.

Furthermore, the successful example in which may turn the tertiary sector measures, could easily influence the residential sector and multiply the final effect in carbon emissions reduction and energy savings.